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# Land Use among Rare Species

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SUBMITTED

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TO:
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## Abstract

This project focused on a site in Lancaster, Massachusetts with potential for development that contains possible habitat for rare species. The practices of low-impact and sustainable development were investigated and to applied to the site, keeping in mind the welfare of the possible rare inhabitants. Three example developments were designed: a typical high-impact development, low-impact, and low-impact with increased sustainability. Using the results from our studies and drawings, conclusions were drawn regarding the different designs, and recommendations were made to potential developers and townships looking to embrace low-impact options.

# Authorship

| | |
|---|---|
| **Background** | |
| *The Importance of Low-impact Development* | Jason Mello |
| *Current Practices in Low-impact development* | Jason Mello |
| **Pine Hill Site Background** | |
| *Current Laws and Regulations* | Matthew Desjardin |
| *Site Analysis* | Matthew Desjardin & John B. Kanis |
| **Example Developments of the Pine Hill Site** | Matthew Desjardin & John B. Kanis |
| **Conclusions and Recommendations** | All Group Members |

AUTOCAD DRAWINGS: Prepared by John B. Kanis and Matthew Desjardin with contributions by DeFalco Engineering.

# Contents

# Introduction

The purpose of this IQP is to investigate the likely courses of action involved in developing a plot of land that is a potential habitat for a threatened species. The project was inspired by a plot of land located in an area of Lancaster, MA known as Pine Hill. The site has been recognized as a potential habitat for several rare species. Also, several natural communities have been flagged as necessary to sustain life for these species. The site is currently being mined for gravel, and there is potential for development in the future. This study examines what effect the threatened species will have on the owner's ability to mine and develop the property, and attempts to optimize the process in order to produce the best outcome for owner, community, and environment.

The following paper is grouped into four main chapters. The first covers background information on the field of low-impact and sustainable development. These practices have been growing increasingly important because of the destructive development methods that have been utilized for many years. Many communities are just beginning to see the effects of the many years of detrimental land use in our society's history. The advantages of low-impact development affect everyone. The owner, community, and environment all benefit when the integrity of the land is not compromised for a quick profit.

The second section contains the information relating directly to the Pine Hill site. Our study of the site begins with the state and local regulations governing the site in Lancaster, Massachusetts. The next phase of research deals with the history of Pine Hill. This includes the site history, such as the fact that steam trains running through the area caused wildfires consistently, thereby changing the physical properties of the land. The geological history is also important to our research because gravel mining has been an important part of the site's past, and

most likely will be in the future. The flora and fauna of the area are inventoried, concentrating on the threatened species and the plants they rely on. AutoCAD drawings display the division of the land according to ecological communities and other physical properties. This section finishes with conclusions about the considerations regarding the rare species that were taken into account in the development of the third section.

The third chapter of the report contains the design of three sample developments. The first of the three is a sample high-impact development, used to emphasize the negative effects of such development practices and the positive aspects of the following two designs. The next sample development is low-impact, designed using the guidelines set forth in the first chapter and the considerations made in the second. The final design is an alteration of the low-impact development, with even more attention paid to the sustainability of the site.

The final chapter of the report contains the conclusions and recommendations based on the findings of the study. This covers the analyses of each of the options, including the salient features of each, and their special considerations. The recommendation of the most beneficial and feasible solution will be based on these analyses.

To summarize, the course of this project was completed in three major steps; knowledge was gathered, subsequently employed, and conclusions were drawn. The first two chapters consider typical practices in low-impact and sustainable land use, as well as site-specific requirements regarding the rare species and their natural communities. The third chapter uses this information to construct three sample developments: high-impact, low-impact, and low-impact with increased sustainability. Finally, conclusive decisions and recommendations were made based on the findings as to the best possible choice for development of the Pine Hill Site.

# Background

## *The Importance of Low-impact Development*

Humans are one of the very few species that drastically alter their habitat to suit their needs. This behavior can be seen everywhere from skyscrapers, to interstate highways, to residential developments. Often times our instinct to build comes at a cost, and nature pays the price. While development will never be one hundred percent impact free, many methods and practices to do exist to curb the potential impact that development has on the environment.

### Problems with destructive development practices

To understand the problems with destructive development practices, one must first understand conventional development. Traditionally, developments completely change the landscape and ecology of the area. Aside from drastic slopes and areas that absolutely cannot be disturbed (i.e. wetlands), the terrain of the development is heavily graded. Often times the roads in developments are oversized for their use and do no connect to other local roads. Traditional developments very seldom contain community areas such as sport fields or picnic areas, which also negates the need for a pedestrian transportation system.

These common practices negatively affect not only the environment, but often lead to high development costs and a lack of community. The heavily engineered roads in many developments, which are often required by town bylaws, require large amounts of land and are expensive to construct and maintain. The terrain grading that occurs is another very costly aspect of traditional development. Large, heavily engineered developments are not only costly to developers. Local and state governments are both directly involved with the permitting of the

development. Traditional developments involve long, costly permitting processes as well as site plan approvals and inspections.

Classic development practices are notorious for negatively impacting the existing environment. The clearing involved with construction roads and house lots destroy large areas of potential habitat and displace many different species. Grading is also extremely destructive to the natural contouring of the existing environment and in turn, the ecosystem. Grading can lead to unnatural flooding and runoff, which is extremely harmful to wetland ecosystems. Traditional developments are also known for isolating families from the rest of the community. Without areas set aside for recreation, the residents of a traditional development seldom get a chance to socialize with their neighbors. This opportunity is further reduced by the lack of sidewalks and public paths, which is a direct result of the absence of recreation areas. The multiple cul-de-sacs and dead ends in classic developments are also to blame for the apparent lack of community. Residents travel to and from their houses on the same pre-determined roads everyday and never encounter anything outside of their path home. The haphazard placement of roads in a traditional development often leads to transportation issues as well.

## *Current Practices in Low-impact Development*

### Encouragement through laws and regulations

The typical community has numerous by-laws concerning the siting and construction of new developments. Examples of common by-laws include minimum road widths, minimum frontage, and maximum resident densities. There are also regulations in place that dictate the impact a development has on the environment. These regulations include wetlands protection, habitat protection, and species protection. The nature of low-impact developments is such that simply by

using a low-impact plan, the most stringent and important laws and regulations are adhered to. Low-impact development plans are especially sensitive to the environment. Communities can encourage the growth of low-impact developments by offering leniency with respect to by-laws concerning road widths or residential densities. For example, if a developer decides to put fifty half-acre lots instead of fifty acre-and-a-half lots on an eighty acre development, the open space is increased from five acres to fifty-five acres. In exchange for the large amount of open space, the local planning board could allow the residential density to be doubled. Similar exemptions can be built into local by-laws to encourage developers to use a low-impact plan.

## Methods for development

Low-impact development plans use a variety of concepts and practices to achieve the desired community. These methods range from simple reconsiderations of designs to more in-depth investigations of the existing environment. One basic concept is to use less heavily engineered transportation systems. Instead of oversized lanes and culverts, more modest roads widths and drainage swales can be used. These roadways should also be designed in a matter that includes multiple thru-streets in and out of the development. This helps stem transportation issues, as well as traffic associated runoff. Street light placement can also be reconsidered to cut down on unnecessary energy use and construction, while insuring that sufficient light is provided.

Conservation subdivision design is one of the major techniques used in the design of low-impact developments. This method of planning allows for at least fifty percent of the buildable land in a development to be permanently protected in undivided open-space. Naturally, there are some areas in a development that are higher in value than others when it comes to preservation. Landscape ecology can be used to determine the natural areas that should be protected. Landscape ecology is the practice of analyzing the terrain and fauna of an area in order to

determine its effect on the overall ecosystem. This practice, along with wildlife studies, is extremely useful in determining the priority of natural features to be preserved. Historic areas should also be top priorities for preservation. The determination of what historical sites, if any, should be preserved is done through the analysis of historical records. Open-space should also be set aside for recreation areas such as a soccer field and disc golf course. Ideally, a network of paths and sidewalks would connect the preserved areas to the entirety of the subdivision. Conservation subdivision design relies on space saving techniques. One basic principle is to create smaller house lots. As previously mentioned, lot sizes could be decreased from one and a half acres to half an acre in order to create more open space. Homes and lots can also be spaced closer together to prevent creating narrow strips of unused land. Cluster development is another space saving method that is employed in creating open-space. Cluster development is the practice of placing house lots in tightly packed groups rather than spacing the lots out. The locations of the "clusters" are dependent on which areas in the development have been sited for protection. Landscape architecture should be used to ensure the visual aesthetics of the development are maintained, despite the close proximity of the homes and the smaller lot sizes.

## Benefits of low-impact development

Low-impact development is the answer to the problems and issues created by traditional developments. When low-impact development plans are used, the developers, residents, state and local governments, and the environment are all positively affected.

*Economic.* Low-impact development plans yield many economic benefits for all of the parties involved. Developers can bypass the construction costs of highly engineered roads by constructing smaller, narrower roads. The smaller house lots associated with cluster development are also less costly to layout and construct. As stated before, the nature of low-impact developments is such that simply by using a low-impact plan, the most stringent and important laws and regulations are adhered to. This allows the review process for the development to flow much quicker and smoother than a traditional development. This allows not only the developer, but also the state and local governments to save money. The property owners in a low-impact development also gain financially. Because the lot sizes are generally smaller than those in a traditional development they are often cheaper. This is compensated by the many acres of open space that the owners have access to. Residents are not responsible for the upkeep of the protected land, and therefore are not financially burdened by it.

*Environmental.* Low-impact developments are extremely environmentally friendly. When determining which areas to protect, conservation subdivision design considers the most environmentally sensitive and important areas. This guarantees that threatened species and habitats are protected as well as possible. In low-impact developments, the preserved land is set aside as permanently conserved areas, which ensures the protection of the species and habitats in the long run. Issues stemming from heavy grading and construction such as flooding, erosion, and runoff are avoided as well. This is because of the "less is better" engineering of a low-impact development. By avoiding the issue of erosion, the preserved areas are further protected.

*Community.* One of the many large issues with traditional development plans is that they do not foster a community atmosphere. Low-impact developments do an excellent job of promoting a sense of a community in a development. With lots placed in clusters and a system of connecting roads, residents more frequently come into contact with one another. Residents of low-impact developments also get more chances to socialize while using one of the many paths in the development, or while enjoying the many acres of open space available to them.

## Practices in sustainable development

Sustainability is based on the theory that the debt—in all forms—accumulated by a community, should be paid off during the life of that community. In other words, resources should be used at at least as low a pace as they can be replenished, and negative effects should be remedied as quickly as they are produced. Practices in sustainable development abound, and only the most relevant will be detailed here.

One practice in sustainable development is the generation of clean energy. Power can obtained from a number of environmentally friendly sources, the most common of which are the sun and wind. Solar energy, typically harnessed by photovoltaic panels on the roofs of the building, can provide a significant amount of electricity. Turbines can harness the power of the wind, assuming there is a steady flow of air. Both technologies are growing at rapid rates. Solar panels are becoming more and more advanced, now approaching their maximum possible efficiency. Wind turbines are also increasing in efficiency, and as importantly, the noise generated by them is decreasing steadily.

As a companion to the production of energy, another tenet of sustainability is the reduction of energy consumption. The orientation of buildings can have a large effect on the heating and cooling, depending on how much sun is allowed into them. This works in

conjunction with the production of solar energy, which requires the photovoltaic panels to be at specific angles to optimize energy production. Green roofs are a great way to reduce both heating and cooling costs, and as an added benefit, they decrease the footprint of the building in terms of impermeable area and carbon neutralization.

In terms of sustainability, water use mirrors energy use. Water may be harvested by any number of methods, and either used for irrigation or cleaned and used for household purposes. A greywater system may also be employed to recycle the water produced during showering, laundry, and other similar activities. The reduction of water use is just as important as harvesting. The most effective way to accomplish a large reduction in water usage is to landscape the area surrounding the developed buildings with plants that do not require watering. Retaining the maximum number of trees on the site also helps reduce the impact on water reserves, and has the added benefit of converting $CO_2$ to oxygen.

A very important practice in sustainable developments is creating communities with residential, commercial, and light industrial. This is often accompanied by regulations allowing the workers of the commercial and industrial businesses first chance at the available housing. The benefits associated make this a very appealing practice. For one, the residents live within walking distance of their place of work, meaning they consume less fuel and reduce their carbon emissions, while gaining beneficial exercise. Also, the net amounts of wholesale and retail goods are reduced, and with careful planning they can almost be neutralized.

# Pine Hill Site Background

This section guides the reader through all relevant information about the Pine Hill site necessary for the design of developments. This includes the laws and regulations set by state and local government restricting the uses and practices, a history of the site in land-use and geological terms, and a summary of the natural communities and their associated rare species. For an aerial photographic view of the site, see Sheet 1 in the Appendix.

## *Current Laws and Regulations*

The laws which govern the Pine Hill site include land use and zoning laws as well as the rules regarding threatened species and their habitats. The zoning laws fall under the jurisdiction of the town of Lancaster, while the state of Massachusetts and its Department of Fisheries and Wildlife reserves the right to restrict land use when it impedes on the livelihood rare species. On the other hand, the federal government restricts land use only in specific cases, none of which relate directly to the Pine Hill site.

### Local regulations (Lancaster, MA)

The Pine Hill plot in Lancaster, MA is zoned as residential, and the uses are currently specified as forest in some areas, and mining in others. The zoning bylaws specify that the only inherent primary uses permitted for residential areas of Lancaster include a one or two family dwelling. In an attempt to reduce the number of new residences, and make the properties that are built higher in quality, Lancaster requires all new sites to be at least two acres in area. Unfortunately, this regulation does not lend itself to low-impact development. In constructing a major residential development, or subdividing a plot into more than six dwelling units, it is necessary to receive

special permission from the Planning Board of Lancaster, granted after an extensive application process. It is likely that if a compelling argument was put forth during this process, citing many of the same benefits of low-impact development presented in the background of this report, the two acre minimum lot size could be bypassed for the good of the community.

When planning a major residential development, it is necessary to consider required lot sizes, setbacks, flood zones, and many other specifications covered in the town's zoning bylaws. These factors will all be considered in the following chapter when creating sample developments on the Pine Hill site.

If a landowner in Lancaster wishes to change the zoning of their land for any commercial or industrial application, they must petition to the zoning board. Petitioners must provide a concept plan, which includes a detailed schematic development plan, floor plans and elevations of all current and planned buildings on the site, land use plans, and analysis of the development's impact on the environment, the economy, necessary public services, and the aesthetics of the area. Another use for the land, allowed by permit of the zoning board, is a residential complex for senior citizens.

The zoning bylaws of the town also cover extensively the restrictions placed on the removal of earth. The article covers both the authorization and enforcement. In order for a landowner to mine his property, the Board of Selectmen must provide a permit which lasts between six and 24 months. The owners of the Pine Hill site have applied for and received the proper permitting to be in accordance with these laws.

## State laws (Massachusetts)

The Commonwealth of Massachusetts has enacted several pieces on legislation relating directly to the possible development of the Pine Hill site. The following is a brief description of each regulation.

*Massachusetts Environmental Policy Act (MEPA).* MEPA is a piece of legislation meant to decrease negative impact on the environment by a process of public review. You are required to submit proposals for all projects which will directly alter 25 acres or more of land, create 5 acres or more of impervious land, alter priority habitat of rare species (see MESA below), or alter a certain amount of wetlands (see WPA below). [1]

*Massachusetts Endangered Species Act (MESA).* MESA is legislation meant to protect rare species in Massachusetts. Functionally, MESA falls under MEPA because the latter provides the submittal framework for the former. Under this regulation, "no person may take, possess, transport, export, process, sell or offer for sale, buy or offer to buy, nor shall a common or contract carrier knowingly transport or receive for shipment, any plant or animal or part thereof on the state list or federal list."[2] These activities are known as "Takes."

The legislation specifies the process by which a project or activity will be reviewed to determine whether it will result in a Take. This power of review under MESA is given to the Natural Heritage and Endangered Species Program, or NHESP, which acts under the Massachusetts Division of Fisheries and Wildlife (MassWildlife), which is part of the

[1] Commonwealth of Massachusetts (2004). 301 CMR 11:00.

[2] Commonwealth of Massachusetts (2006). 321 CMR 11:00.

Department of Fish and Game. If MassWildlife finds that a project involves a Take, it may be revised and resubmitted, or an appeal may be filed.

MESA also puts the responsibility of maintaining the list of rare species in Massachusetts to NHESP. Within this list, the rare species are classified under three categories. These categories, from strongest to mildest is endangered, threatened, and species of special concern.

*Massachusetts Wetland Protection Act (WPA).* This piece of legislation is very similar to MESA. It is designed specifically to protect wetlands and the species living in them. After filing with MEPA, if certain project characteristics are present, it may be necessary for NHESP to conduct a review to see if the project will have a significant effect on the wetlands.

*Massachusetts Forest Cutting Practices Act.* This act is meant to protect endangered species by regulating forest cutting practices. It requires that any person removing forest products from areas designated as forests must declare their intentions to the assessors of their town to determine whether the project can continue. The person or agency must receive a final work order and designated file number to proceed with the activity.

## *Site Analysis*

This site analysis is a first look at Pine Hill. This covers the geological history of the area as well as how the land has been utilized over the past centuries. The natural communities were researched and the possible wildlife of the site was investigated. The primary analysis ends with the division of the land according to natural communities and other physical properties, and conclusions about the site which aided in the sample developments.

## Geological history

The Nashua River valley drains north-northeast, from a large watershed outside of Worcester, MA to Nashua, NH. Three major tributaries, the Stillwater, North Nashua, and Squannacook Rivers join the valley from the northwest. The result was a large glacial lake named Lake Nashua during the retreat of the last Wisconsin ice sheet to overrun New England. Large volumes of sand, gravel, silt, and clay were deposited throughout the valley in deltas, lake bottoms, and outwashes. The series of ice dams that formed the lake eventually gave way, causing various levels in deposits and large amounts of sand to wash into the middle of the valley. The outflow of water washed out the sediments to the east up to the drumlin of Wittemore Hill and west to Still River, leaving a seventy-foot-high plateau of sand, silt, and fine stone that became know as Pine Hill.

## Land use history

Incorporated in 1653, Lancaster is the oldest town in Worcester Country and is considered the "mothertown" for many of the surrounding towns. Located on northern side of town, Pine Hill was named after the abundant large white pines that created a high canopy over the other plant life. Initially the land was not settled because it was separated from the main road to Harvard and it was too far from the center of town. As a result, it was divided among the more prominent residents, giving each of them a supply of valuable wood to use for building homes, barns, furniture, tools, and heating in the cold harsh winters. Pine Hill was so isolated that from 1790 to 1794, a small pocks infirmary was established on the northern side. This spurred a small neighborhood of homes to be built, but after the public road was suspended, the buildings were relocated closer to town.

Until the railroad came through in 1946, Pine Hill remained unchanged and one of the most beautiful places for residents to roam and enjoy. Along with the railroad came forest fires from the steam engines. Most of the great white pines were burned and scrub brush and blueberry bushes took over between fires. With the wood gone and the beauty destroyed, the smaller lots were grouped together and sold to the wealthier residents and farmers around the time of the great depression. At the same time, Fort Devens was established, cutting off the road from Lancaster to Harvard. All the land east of the railroad became part of the base. Shortly following Second World War a small airport was constructed for a short time and the mining of the sand began. The constant brush fires that devastated the white pine forests came to an end with the introduction of diesel locomotives in the mid 1900s.

## Natural communities of Pine Hill

A natural community is a grouping of the types of wild life in a certain area. Many times similar soil qualities, climates, and other special circumstances will yield specific types of plant life, and therefore certain animals will inhabit the land. Massachusetts is home to over 40 different communities.

*Pitch pine-scrub oak communities (PPSO).* [1] This community is dominated by shrubs, often very dense with scattered openings. The community is develops on low nutrient soils and is fire dependent. Most species recover quickly from fire. The vegetation of this community consists of pitch pines forming an open canopy above a layer of shrub oaks and scrub oaks. The scattered

[1] Swain, P. C., et. al. (2001), "PITCH PINE-SCRUB OAK COMMUNITY"

openings are home to sandplain grassland vegetation, most often lowbush blueberry, little bluestem grasses, and lichen patches.

There are many species of lepidopterans confined to this community. These will be addressed in the next section. Whip-or-wills and the common nighthawk use the scattered openings and are becoming increasingly restricted to these areas. The rest of the bird species are similar to those of oak forests. Some threats to these areas include development, fragmentation, and erosion, but the greatest threat to these environments is the suppression of fire. Without mechanical clearing and prescribed burns to control the plant life, the areas evolve into pitch pine-oak or similar forests.

*Successional white pine forests.*[1] In these communities, the dominant plant life is white pines which are decades old. The ground is covered in shed pine needles, and the layer of underbrush is thin. Other plant life includes white oak, red oak, red maple, elderberry, black cherry, and maple-leaved virburnum. Blackberry vines, poison ivy, lowbush blueberry, and black huckleberry appear in disturbed or recently disturbed areas.

There are many species of birds native to this community, but there are no known native rare animals. The only major threat to successional white pine communities are invasive species such as buckthorn, morrow's honeysuckle, and privet. To maintain these communities these exotics should be removed.

[1] Swain, P. C., et. al. (2001), "SUCCESSIONAL WHITE PINE FOREST"

*Sandplain grasslands.*[1] Sandplain grasslands are dominated by grass, but shrubs play an important role. The community develops on low nutrient soil. It often occurs in the openings and on the outskirts of pitch pine-scrub oak communities. The vegetation consists of little bluestem, Pennsylvania sedge, and poverty grasses, as well as bearberry, scrub oaks, bayberry, lowbush blueberry, and black huckleberry.

Many small mammals such as voles, mice, and shrews, as well as a few bird species call this community home. The black racer snake also inhabits the area. A number of hawks and owls also use the grounds for hunting. There are a number of rare species of plant and animal known to be associated with sandplain grasslands. There are a number of invasive species which are a threat to the sandplain grasslands, including a number of exotic grasses. Management of the community involves periodic prescribed burns or mowing, and removing exotics. There is a great deal of this habitat at Pine Hill, in the areas surrounding the site of interest.

*Cultural grasslands.*[2] These grasslands, unlike the sandplain grasslands, are human created and maintained. They are usually maintained by mowing. These grasslands usually occur on low nutrient soil and often border pitch pine-scrub oak communities. The areas include airports, cemeteries, hayfields, and other fields. The grasses are usually little bluestem, Pennsylvania sedge, poverty grass, and many non-native species. Many of the species of birds, small mammals, and snakes which use and live in other grasslands use cultural grasslands as well, and many of the same rare species are associated. Fire management and reduction of exotics can help maintain the grasslands.

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[1] Swain, P. C., et. al. (2001), "SANDPLAIN GRASSLAND"

[2] Swain, P. C., et. al. (2001), "CULTURAL GRASSLAND"

*Wetlands.* Wetlands are not a natural community in particular. Wetlands are present in all regions of the world, as the classification is merely based on water content of the land. For our purposes we will use it as a classification, because although it includes the marshes and streams present on the site, neither of these communities will be developed upon for the following reasons. To begin with, the land is not good for building on. A great amount of fill is required to make the land useable, and that practice has many adverse effects on the surrounding environment. As important is how heavily protected they are due to the rich diversity of wildlife. Under the state regulations discussed on page 18, such a project would never stand up to review by NHESP under WPA and MESA.

## Rare species of Pine Hill

Information regarding the rare species which may be present on the Pine Hill site was requested by John Farnsworth of DeFalco Engineering Services. In the subsequent correspondence from MassWildlife, they cross-referenced the rare species of Lancaster with the types of natural communities present on the site to determine which species may be present on the site. Table 1 contains the information listed in the letter from MassWildlife, including a brief description of their taxonomic group and the severity of their rare species status.

**Table 1: Possible rare species of the Pine Hill site**

| Scientific name | Common name | Taxonomic group | State status |
|---|---|---|---|
| Emydoidea blandingii | Blanding's Turtle | Reptile | Threatened |
| Itame sp. 1 near inextricata | Pine Barrens Itame | Moth | Special Concern |
| Zanclognatha martha | Pine Barrens Zanclognatha | Moth | Threatened |
| Psectraglaea carnosa | Pink Sallow | Moth | Special Concern |
| Lycia rachelae | Twilight Moth | Moth | Endangered |
| Carex typhina | Cat-tail Sedge | Plant | Threatened |
| Stylurus scudderi | Zebra Clubtail | Dragonfly | Endangered |
| Glyptemys insculpta | Wood Turtle | Reptile | Special Concern |
| Botaurus lentiginosus | American Bittern | Bird | Endangered |
| Ixobrychus exilis | Least Bittern | Bird | Endangered |
| Rallus elegans | King Rail | Bird | Threatened |
| Ambystoma laterale | Blue-spotted Salamander | Amphibian | Special Concern |

*Blanding's Turtle*.[1] The Blanding's Turtle is typically 8 to 10 inches long, and can be identified by its hinged, yellow bottom shell, long yellow throat, and notched upper jaw. It is primarily aquatic, living in shallow ponds and marshes. It feeds on aquatic plants and small aquatic wildlife, and may leave the water to feed on vegetation, slugs, insects, and earthworms.

The females do not reach breeding age until twelve years of age. They leave the water and lay their eggs on sand banks. Clutches of six to eleven are laid in June and hatch in September. The threats these turtles face include habitat loss, road mortality, and predation during youth. Their late age of sexual maturity makes it difficult for this species to survive.

[1] NHESP (2007). "Blanding's Turtle"

*Wood Turtle*.[1] The Wood Turtle has a shell with pyramidal sections and orange coloration on neck and legs. It grows to approximately 5½ to 8 inches long. It has been spotted in New England, north to Nova Scotia, south to Virginia, and west to Minnesota. It is an opportunistic omnivore, feeding on vegetation and small animals on land and in the water. The turtle prefers slow moving streams with sandy bottoms and dense vegetation along the banks.

Female wood turtles lay one clutch which average seven eggs every year. They lay their eggs on sandy banks. They are laid in June and hatchlings emerge in September. The life expectancy of a wood turtle is over 46 years, but they may live up to 100 years of age. The threats they face include high youth mortality, late sexual maturity age, hay-mowing, development, forestry, and pollution.

*Blue-spotted Salamander*.[2] The Blue-spotted Salamander is slender, approximately 4 to 5½ inches long at adulthood, and dark blue to black with sky blue spots or specks. They cover a great range, north to the Canadian Maritime Provinces, south to New Jersey, and west to Minnesota and Wisconsin. They require moist, shaded habitat in which to live, and vernal pools or temporary ponds in which to deposit their eggs. Clutches of 82 to 489 eggs hatch and metamorphose completely before august when they begin lying dormant. The adults feed on small invertebrates and may live for over a decade. The major threat for these salamanders is the draining and filling of vernal pools for development.

[1] NHESP (2007). "Wood Turtle"

[2] NHESP (2007). "Blue-spotted Salamander"

*American Bittern*.[1] This mottled brown heron is 23 to 34 inches long with a wingspan of 32 to 50 inches. The species inhabits freshwater marshes and brackish wetlands with emergent vegetation in which it can hide. Three to five eggs are laid in a nest with diameter of one foot, located in wetlands or the adjacent upland fields. Their food includes most types of small animals. They are located across the United States and travel as far south as the Caribbean and south Central America in the winter.

*Least Bittern*.[2] The smallest member of the heron family, the Least Bittern is 11 to 14 inches long with a wingspan of 16 to 18 inches. It has a black and green head and back and buff and chestnut wing patches. The bird is located throughout southern Canada and northern America, wintering around the gulf coast. It resides in freshwater marshes where cat-tails and reeds predominate. Low and declining amounts of suitable habitat contribute to their rarity in Massachusetts.

*King Rail*.[3] The King Rail is chicken-sized with a long slender beak and olive-brown streaked feathers. It resides in freshwater and brackish marshes with emergent vegetation, as well as the adjacent fields. They feed on small invertebrates, frogs and tadpoles, grains, and aquatic vegetation. Their range covers most of the eastern half of the country. During the winter they stay within their normal range but may move into the southern areas. The mother nests in grass

[1] NHESP (2006). "American Bittern"

[2] NHESP (2007). "Least Bittern"

[3] NHESP (1986). "King Rail"

or sedge, lays 10 to 12 eggs, incubates them for 21 to 23 days, and remains with them for at least a month. They can fly at 9 weeks of age.

*Zebra Clubtail*.[1] The Zebra Clubtail dragonfly is about 2 to 2.3 inches in length. The thorax is striped with black and yellow, and each of the ten black abdomen sections is separated by a yellow strip, prompting the zebra name. The seventh, eighth, and ninth sections of the abdomen are swollen, hence the clubtail. In Massachusetts, the zebra clubtail inhabits small streams with intermittent rapids. The distinct stages of life for the dragonfly are the aquatic nymph stage and the aerial adult stage.

*Pine Barrens Itame*.[2] The Pine Barrens Itame has a wingspan just under an inch, and has brownish-gray forewings and cream colored hind wings. They inhabit PPSO communities in New England, New York, Pennsylvania, New Jersey, and some Appalachian Mountain areas. The eggs of this moth overwinter and the larvae hatch in early spring to feed on new growth of scrub oak. The larvae pupate by June and flies in late June or July.

*Pine Barrens Zanclognatha*.[3] This moth is dark brown with a wingspan of about one inch. Pine Barren Zanclognathas inhabit PPSO communities in New England, New York, New Jersey, Pennsylvania, and the Appalachian Mountains of Ohio, Virginia, and North Carolina. The larvae

[1] NHESP (2003), "Zebra Clubtail"

[2] Nelson, M. W. (2007). "Pine Barrens Itame"

[3] Nelson, M. W. (2007). "Pine Barrens Zanclognatha"

feed on the detritus of the pitch pine and the scrub oak. The larvae overwinter and continue feeding in the spring. They pupate in June and fly in July.

*Pink Sallow Moth*.[1] The Pink Sallow Moth has a wingspan of about 1½ inches. Its forewings are deep red and the hind wings are cream colored and pink. The moth resides in PPSO communities and heathlands spottily distributed in a wide area surrounding the great lakes, east to Maine and Massachusetts, and south to Pennsylvania and New Jersey. The eggs overwinter and hatch in the spring. The larvae feed most likely on low-bush blueberry. They pupate by July and fly in September and October.

*Twilight Moth*.[2] This moth resides in mixed-wood and deciduous forests in Alaska, the southern provinces of Canada and south to the Rockies, New England, and Pennsylvania. The Twilight Moth adults fly in early spring, often before the last of the snow has melted. The larvae feed on mixed deciduous shrubs, and pupate September or October, with the pupa overwintering.

*Cat-tail Sedge*.[3] The only plant on this list, the cat-tail sedge is a grass-like perennial which grows about one to three feet high in dense clumps. The plant grows in areas covering most of the eastern half of the country and into southern Canada. The sedge grows only in forest floodplains and the adjacent areas, where spring flooding occurs. The greatest threat to the cat-tail sedge is the clearing of its habitat for agricultural uses.

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[1] Nelson, M. W. (2007). "Pink Sallow Moth"

[2] Schmidt, B. C. (2003).

[3] NHESP (K.S.) (1993). "Cat-tail Sedge"

## Division of land

The next step was to make a drawing of the Pine Hill Site divided by natural communities. This aided in drawing conclusions of how to approach the example developments, keeping in mind the rare species and their associated habitats. This drawing can be seen on Sheet 2 in the Appendix.

## Conclusions concerning the rare species of Pine Hill

One group of rare species to consider is that of the wetlands dwellers. The Blanding's Turtle, Blue-spotted Salamander, American Bittern, Least Bittern, King Rail, and Cat-tail Sedge may live in the marsh wetlands of the site. No development will be planned on these areas, and a 50 foot buffer will serve as another mechanism for the safety of these species. The Wood Turtle and the Zebra Clubtail, which may reside in the waters of the Nashua River, will be protected by the 400 foot buffer zone around the banks of the stream.

The Twilight Moth resides in mixed-wood and deciduous forests. This species is not of great concern, because the type of habitat in which the moth lives is abundant. Even if a great deal of these forests were removed for development, it would not result in a Take, because there is an abundance of this type of habitat in surrounding areas to which these moths could be displaced.

The most critical habitat is that of the Pine Barrens Itame, Pine Barrens Zanclognatha, and the Pink Sallow Moth. These rare species reside in Pitch pine-scrub oak communities, which are dwindling due to fire suppression. Much of the earth to be mined on the Pine Hill Site is located below these communities, which could result in a Take if it is not approached properly. Through a site walk with representatives from MassWildlife and NHESP, it was learned that habitat relocation has been performed in the past with positive results. This process would start

by removing the topsoil from these areas, and storing it while the earth is mined. Then, once the sand has been removed, the same topsoil is spread over the area. This topsoil contains the seeds of all the primary plant life that constitutes this natural habitat, and consequently, in a matter of a few years, the pitch pines and scrub oaks will have taken hold and reemerged in their new location. Alternatively, entire plants can also be transplanted, a more complicated process which cuts the recovery time for the habitat. With either method, the mining and relocation should be done in small steps in to allow some recuperation time. This way, if the moths are in fact residing on the property, they are not all killed in the process. The other consideration for PPSO communities is the need for prescribed burns. If the final location of the PPSO communities and the building lots allow it, prescribed burns could be implemented in the future to maintain the plant life. Otherwise, it is likely that the lack of fire could mean the PPSO communities would evolve into a more permanent mixed-wood forest.

# Example Developments of the Pine Hill Site

This chapter guides the reader through the process of design developments on the Pine Hill Site. Each section discusses the design considerations taken into account when designing the layout of the site.

## High-impact residential development

The example high-impact residential development (Sheet 3 of the Appendix) follows all regulations and restrictions put forth by the town of Lancaster, the state of Massachusetts, and MassWildlife. In fact, it follows the town by-laws more accurately than the low-impact developments to follow. The town of Lancaster requires a house lot to be two acres in an attempt to reduce the number of lots being developed, but the negative effects of such outdated and unprogressive zoning regulations can clearly be seen by the drastic effect this style of development would have on the ecosystem in the area.

## Low-impact residential development

In order to develop an example low-impact development, it was necessary to first locate the primary and secondary conservation areas of the site. A site layout containing these areas can be seen on Sheet 4 of the Appendix. Then the locations of the roads, houses, and walking trails were designated.

*Conservation Areas*. As discussed in the Background of this report, primary conservation areas are the main areas to remain undisturbed, around which the development must be designed. The primary conservation areas of Pine Hill cover wetlands, habitat belonging to endangered

species, and steep slopes. The primary conservation areas are outlined in red on Sheet 4 of the Appendix. The wetland conservation area also includes a 50 foot buffer around all the marshes and a 400 foot buffer from the Nashua River. The ecology in this area is very fragile and hard to accurately recreate. A large area of pitch pine-scrub oak natural community to the north is included because it is completely undisturbed and is a possible habitat of the endangered moth species. There are also steep slopes around the pond and at the edge of the sand plateaus where development would be destructive to the natural features of the land.

Secondary conservation areas protect the beauty of the land, historical importance, the ability of an ecosystem to function, and recreational areas. Most of the land on Pine Hill is made up of secondary conservation areas. The northern half of the site was set aside as open space to adhere to the neighboring National Heritage Protection Land to the west and the Nashua River Preserve to the east. This large area provides extensive habitat and undeveloped space. The remaining southern half has been historically farmed and taken care of for the past decade, making it difficult to qualify the importance of various features. Tree lines around fields and cultivated farmland were included for aesthetics and future use. Additional land adjacent to wetlands was also conserved to further protect the delicate ecology and preserve the beauty of the pond. The existing pathways around the pond and along the river make it a good recreation area, and were thus conserved. The recreation area can be used for exercise, catch-and-release fishing, and paddling in small boats. Although the pond was included in the primary conservation area due to development regulations, it is a man-made and encompasses a durable ecology. The white pines were included as part of a heavily used wildlife corridor that goes north-south along the river and east-west along either side of the pond.

*Lancaster Master Plan.* It may be necessary to set aside certain areas for other necessary components, and take other layout considerations into account. For a town to accept a proposed development, it needs to fit in to the town's Master Plan. The Master Plan for Lancaster focuses on protecting the landscape and creating a community with a high quality of life. The development should incorporate local values and traditional aesthetics. This involves making the building architecture, road design, and site layout similar to the rest of the town.

*Design of low-impact development.* It is important to note that for the purposes of this low-impact development, the minimum two acre lot size required by Lancaster was overlooked, as were the road width regulations. This was done in hopes that if it were submitted to the town for approval, the fact could be overlooked considering the immense benefits brought forth by the design.

The example low-impact residential development (see Sheet 5 of the Appendix) takes many design consideration into account to provide the safest and most pleasant living conditions for the inhabitants. To begin with, the secondary conservation areas were preserved as much as possible, and the primary conservation areas were avoided all together. The design places the houses among trees to reduce their effect on the surrounding landscape and preserve scenic views. The cultivated land has also been left to preserve the history of the land and make the development more sustainable by providing areas for recreational activities. The residential units have been placed so that their rear view is that of rural farmland with no other houses in site, yet they are close enough together to create a community feel among neighbors. Road widths and curvature were not designed to Lancaster's regulations so as to reduce impervious area and make the roads similar to the rest of the town. Safety and fire truck access was taken into account by

reducing blind curves and using loops at dead end roads rather than large cul-de-sacs. Most of the roads are placed on already existing farm paths making them flow and feel like they an old part of town. Other components that were considered but not included in our drawings include utility placement, septic systems, leach fields, water supply, and other intentions of the land owner. The low-impact residential design incorporates well-managed conservation and traditional design to reduce the effects of urban sprawl and modern day development.

## Mixed-use sustainable development

For the highest and best use of a piece of land, the development needs to incorporate sustainability with low-impact design methods. The example of a mixed-use sustainable development (see Sheet 6 in the Appendix) reduces dependence on the outside world.

The element most crucial to the actual layout of the site is the mixed-use nature. Commercial and industrial businesses are incorporated into the design to give jobs to the new residents, reduce the need to commute to work, and apply less strain on the town's transportation system. This also allows extra exercise for the residents by allowing them to walk or bike to work. In the stipulations surrounding the development, employees of the commercial and industrial businesses could be required to live on site, or in a less extreme case, get first priority for housing.

Many other design considerations should be taken into account, but were not necessary in laying out the plan of the site. The development should have its own well and small wastewater treatment facility depending on its size and the availability of the town's utilities. Lancaster is a small town with a new treatment plant that can be accessed to handle the commercial and industrial waste. There is an abundance of good soil on the site allowing for the use of Title 5 septic systems for the residential units and a deep well to be placed on the northern end of the

site. Energy could be produced using photovoltaic panels or wind turbines, and efficient appliances and LEED certified building designs will cut down on electricity and natural gas dependence.

## Conclusions and Recommendations

In contrasting the residential and mixed-use low-impact developments with the example high-impact development, the many advantages to low-impact practices were made apparent. By decreasing lot sizes dramatically, it was possible to group the residences in small clusters. One implication of this practice is that the amount of open space is dramatically increased. The number of dwellings was increased from 67 in the high-impact model to 71 in the low-impact model, yet the open space was more than doubled. The strategic placement of this open space in areas such as critical habitat in which rare species may live, areas of historical significance, and possible recreation areas improves the ecology of the area as well as the quality of life for the residents. Another implication of clustering the dwellings is a greater sense of community. The residents are more likely to build meaningful relationships with each other when there are not great distances between houses. The shared fields where group activities can occur also have a positive effect on the relationships between inhabitants.

Another effect of the low-impact developments is the decreased length of roads. The overall length of the roads was decreased by about 5000 feet, or about 35% between the high- and low-impact designs. In addition, the roads were made narrower. This dramatic decrease in impermeable land has a strong positive effect on the water use in the community, allowing more precipitation to be absorbed by the ground instead of entering the drainage system.

Not only would the environment and community benefit from the low-impact development, but it is likely that the owner of the Pine Hill Site would benefit economically and be able to pass those savings on to future owners. The building of houses in small clusters has the effect of lowering contracting costs, in addition to the lower cost of infrastructure, including roads and utilities.

The added benefits of the sustainable mixed-use development are numerous. This design goes above and beyond the low-impact design. With proper planning, the net change in commercial and industrial goods could nearly be reduced to zero, as could the amount of outside jobs held by residents and inside jobs held by outsiders. This, combined with improvements made to the design of the houses to improve energy and water use, could have the effect of making the community nearly self-sufficient. This option should certainly be considered by the owner of the Pine Hill Site, as both an economically beneficial and environmentally friendly alternative.

In addition to these recommendations to the owner of the site, it is also recommended that the Town of Lancaster and all other towns embrace the practices of low-impact development through any number of measures. Under the current regulation, many special permits and petitions would be required to develop a low-impact or sustainable development on Pine Hill. Instead, the town should encourage these practices, and discourage the type of developments their current regulations require. This could be achieved by two major means: restrictions and incentives. For example, the portion of the project area to be turned into lot space could be restricted to 50%. Incentives could be used to encourage LEED certified buildings, rainwater harvesting, energy production and savings, and well designed mixed-use developments. In the end, this would not nullify the goals that the current regulations are meant to achieve, because in the end, the Zoning Board has the final say, and can deny permission to any proposed development not in line with its Master Plan.

Low-impact and sustainable designs should be considered for any potential developments. Owners should embrace them as a way to improve the community and environment of the area, and should recognize that they are often a more economically beneficial

solution. Towns should encourage these practices by adjusting their zoning regulations to place restrictions, such as maximum lot sizes rather than minimums, and provide incentives for environmentally friendly practices. The increasing populations inhabiting our country and world require progressive zoning regulations in order to keep up with our increasing knowledge and our changing needs. Low-impact and sustainable development practices must be embraced before irreversible sprawl has ruined the cultural and environmental qualities of our communities that we all hold dear.

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# Appendix

The following sheets contain all drawings developed for this project. The following is a summary of these drawings:

**Sheet 1:** Aerial Photo of the Pine Hill Site

**Sheet 2:** Natural Communities of Pine Hill

**Sheet 3:** Example of a High-impact Residential Development

**Sheet 4:** Location of Conservation Areas

**Sheet 5:** Example of a Low-impact Residential Development

**Sheet 6:** Example of a Mixed-use Sustainable Development

Aerial Photo from Google Earth
Copyright 2008

0' 500' 1,000'

MAGNETIC

| | |
|---|---|
| Land Use Among Rare Species | |
| Sheet 1 | |
| Aerial Photo of The Pine Hill Site | |
| Date: 3-10-2008 | John Kanis<br>Matthew Desjardin<br>Jason Mello |
| Scale: 1" = 500' | |

Total Project Area: 276 acres
Woodland Area: 150 acres
Grassland Area: 75 acres

MAGNETIC

Cultural Grasslands

Area Under Transormation

Pitch Pine - Scrub Oak Community (Logged 12 years ago)

400' River Offset

Pitch Pine - Scrub Oak Communities

Sandplain Grasslands

NASHUA RIVER

Pitch Pine - Scrub Oak Communities

Man-Made Pond

Cultural Grasslands

Cultural Grasslands

Swamp/Wetland

Wetlands

Cultural Grasslands

Successional White Pines Forest with Controlled Underbrush

400' River Offset

Cultural Grasslands

NASHUA RIVER

Cultural Grasslands

0' 500' 1,000'

# Land Use Among Rare Species

## Sheet 2

## Natural Communities of Pine Hill

Date: 3-10-2008

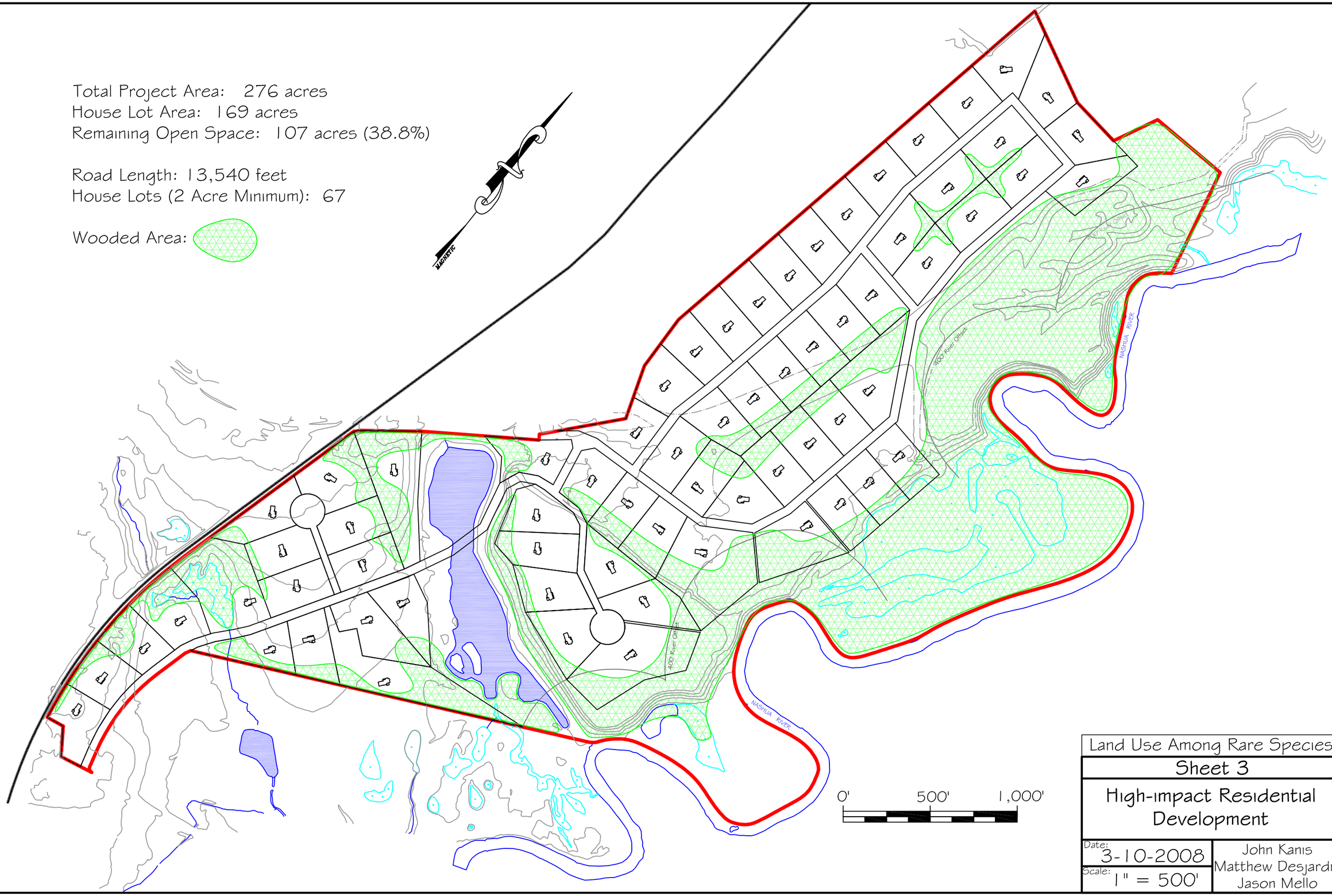
Scale: 1" = 500'

John Kanis
Matthew Desjardin
Jason Mello

Total Project Area: 276 acres
House Lot Area: 169 acres
Remaining Open Space: 107 acres (38.8%)

Road Length: 13,540 feet
House Lots (2 Acre Minimum): 67

Wooded Area:




Land Use Among Rare Species

Sheet 3

High-impact Residential Development

Date: 3-10-2008

Scale: 1" = 500'

John Kanis
Matthew Desjardin
Jason Mello

Aerial Photo from Google Earth
Copyright 2008

Primary Conservation Areas

Secondary Conservation Areas

Project Boundary

0' 500' 1,000'

MAGNETIC

Land Use Among Rare Species

Sheet 4

# Conservation Areas of Pine Hill

Date: 3-10-2008

Scale: 1" = 500'

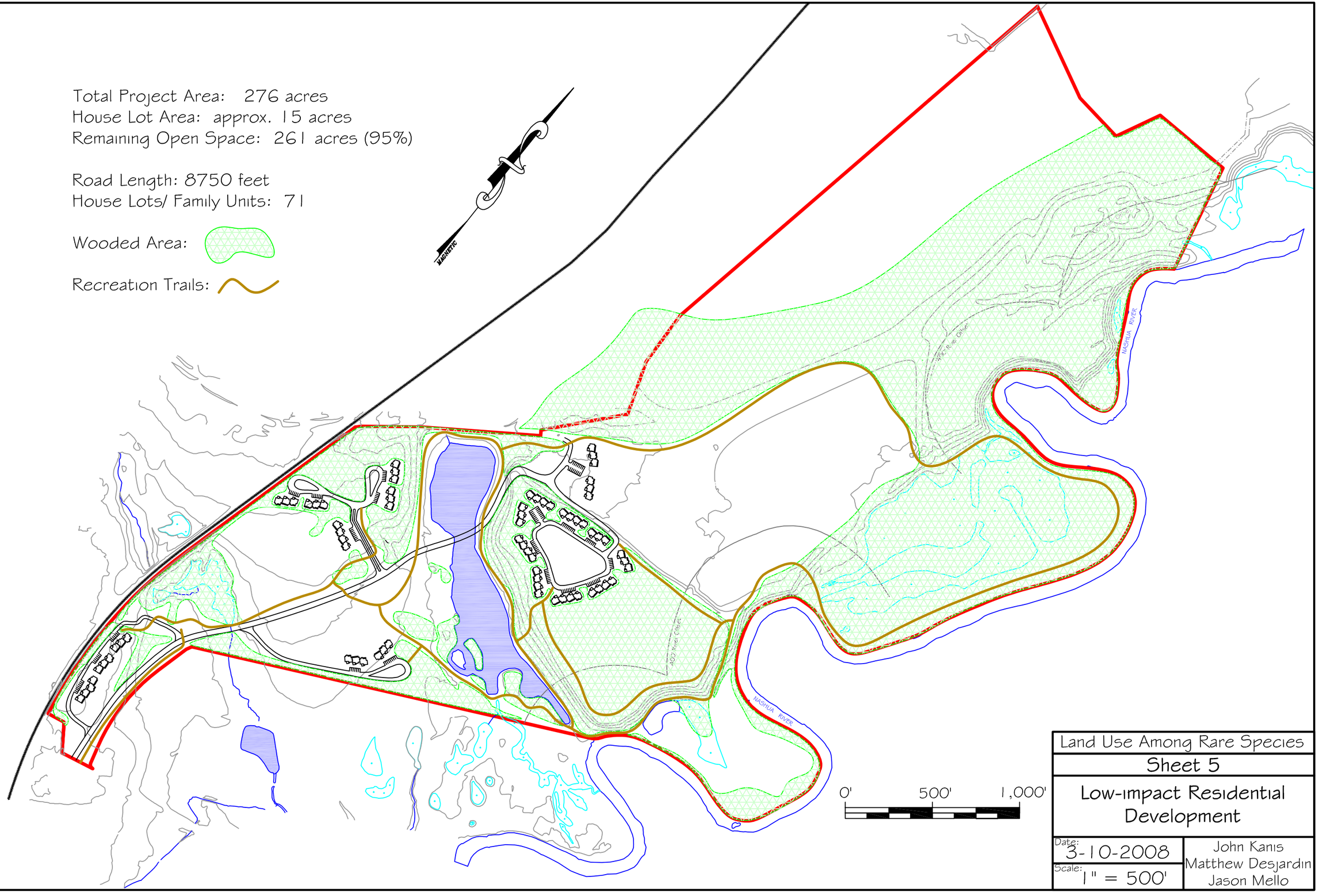
John Kanis
Matthew Desjardin
Jason Mello

Total Project Area: 276 acres
House Lot Area: approx. 15 acres
Remaining Open Space: 261 acres (95%)

Road Length: 8750 feet
House Lots/ Family Units: 71

Wooded Area:

Recreation Trails:




Land Use Among Rare Species

Sheet 5

Low-impact Residential Development

Date: 3-10-2008

Scale: 1" = 500'

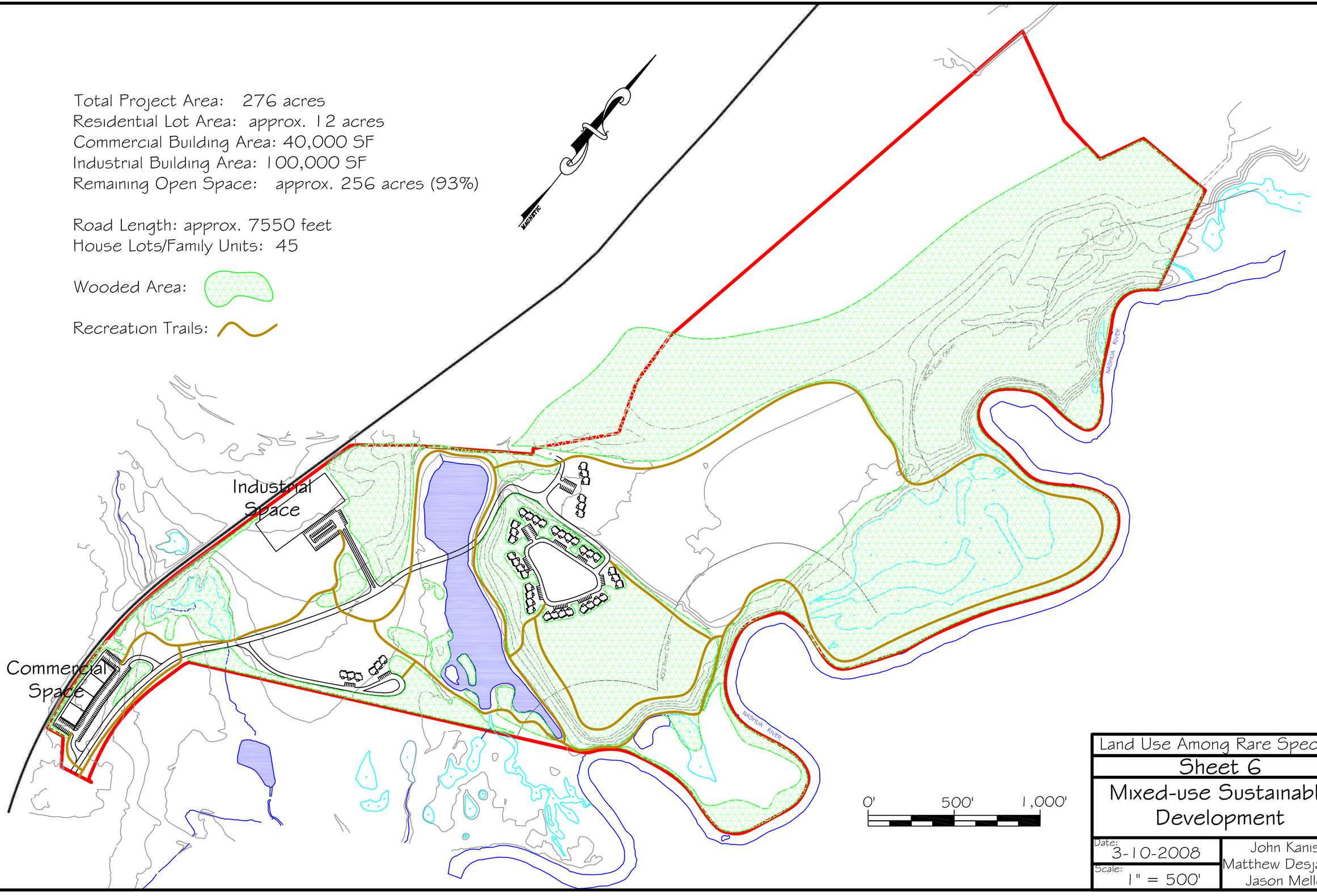
John Kanis
Matthew Desjardin
Jason Mello

Total Project Area: 276 acres
Residential Lot Area: approx. 12 acres
Commercial Building Area: 40,000 SF
Industrial Building Area: 100,000 SF
Remaining Open Space: approx. 256 acres (93%)

Road Length: approx. 7550 feet
House Lots/Family Units: 45

Wooded Area:

Recreation Trails:




Land Use Among Rare Species

Sheet 6

Mixed-use Sustainable Development

Date: 3-10-2008

Scale: 1" = 500'

John Kanis
Matthew Desjardin
Jason Mello